

Adaptive Management Framework for the California Water Fix (CWF) and 2008/2009 Biological Opinions on the combined operations of the Central Valley Project (CVP) and State Water Project (SWP)

This draft Adaptive Management Framework describes concepts to develop an adaptive management program for the CWF joint ESA Biological Opinion (BiOp) and 2081(b) Incidental Take Permit (ITP), and the CVP/SWP 2008/2009 BiOps and CESA authorizations. Ultimately, the program would address uncertainty associated with the effectiveness of management actions taken to prevent jeopardy and adverse modification of critical habitat to federally listed species and to prevent jeopardy and minimize and fully mitigate effects on state listed species from: ongoing operations of the SWP/CVP, habitat restoration actions required for CWF and/or the 2008/09 BiOps and CESA authorizations, and from future construction and operation of the proposed CWF, including the proposed North Delta Diversion (NDD) screen design.

I. INTRODUCTION OF FRAMEWORK

A. Five Agencies are Developing an Adaptive Management Program Based on this Framework

- CVP and SWP water operations agencies (U.S. Bureau of Reclamation and Department of Water Resources, respectively)
- Federal and State fisheries agencies (U.S. Fish and Wildlife Service, National Marine Fisheries Service and California Department of Fish and Wildlife),

B. Framework Purpose

Through this Framework the Five Agencies commit to developing an adaptive management program to guide the ongoing operation of the CVP and SWP and future implementation and operation of the CWF. The adaptive management program will be complete prior to the issuance of the CWF BiOp. Critical to effective implementation of ongoing CVP/SWP operations now and with CWF is enhanced application of science to support decision making related to the operations of the CVP/SWP and to support achievement of the co-equal goals of the Delta Reform Act of 2009, providing a more reliable water supply for California and protecting, restoring and enhancing the Delta ecosystem.

C. Framework Goals

1. Provide a basis for the creation and implementation of an adaptive management program for long-term operations of the CVP and SWP, both now under the existing 2008/2009 FWS and NMFS Biological Opinions, and in the future under CWF.
2. Describe the basic processes and governance principles to enhance the application of best available science to all aspects of decision-making, on multiple time steps (multi-year, annual planning/forecasting, and real-time operations).
3. Describe how management relevant science will be augmented in the areas of integrated monitoring and research, mechanistic studies and models, synthesis, and data access.

D. CWF and 2008/09 BiOps Adaptive Management Program Scope

1. Inform and improve on:

- a. Operation of SWP/CVP facilities within the Delta under the existing BiOps and CESA authorizations and the new CWF joint BiOp and 2081(b) permit,
 - b. Design of fish facilities, including the proposed NDD fish screens, and
 - c. Habitat restoration and non-operational mitigation relative to in-Delta SWP/CVP operations under existing and new BiOps and CESA authorizations.
2. Ensure the ongoing SWP/CVP operations and future construction and operation of the CWF are implemented in a way that reflects the current state of scientific understanding and improves the viability of the species to the extent possible.
 3. Maintain and improve water supply reliability, to the extent possible.
 4. Communicate (provide transparency) to the broader community of state, federal and local agencies, the public, universities, scientific investigators, public water agencies and nongovernment stakeholders how existing operations will be assessed, how new scientific investigations will be prioritized, and carried out, and how the results of those investigations will be integrated into adaptive management decisions.
 5. Build on and support existing efforts of the Interagency Ecological Program, Collaborative Science and Adaptive Management Program, Delta Stewardship Council/Delta Science Program, and other relevant individual agency science initiatives.

II. ADAPTIVE MANAGEMENT PROGRAM OVERVIEW

A. Adaptive Management Defined

“Adaptive Management” defined in 2009 Delta Reform Act (California Water Code section 85052) to mean “a framework and flexible decision making process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvements in management planning and implementation of a project to achieve specified objectives.”

- Adaptive Management at a basic level is a learning cycle and feedback loop whereby resource managers may, simultaneously, manage and learn about a single or set of natural resources. AM is inherently collaborative, requiring “communication and transparency among all interest groups as well as a willingness to overcome the institutional barriers to collaborative decision-making” (Luoma *et al.* 2015).
- General framework for adaptive management developed as a structured decision-making process that incorporates uncertainty about the potential responses of resources to management actions, which then relies on flexible decision-making that is adjusted as outcomes from management actions and other events become better understood (Holling (1978), and Walters and Hillborn (1978)).
- Adaptive management process requires defined management objectives and clearly identified sources of ecological uncertainty that respectively become the basis for, and barriers to, a desired resource management regime (Williams, 2010). Based on those objectives and the identification of uncertainty, resource managers develop hypotheses about the potential resource responses to management actions, and then manage the resource in a way that incorporates explicit assumptions about those expected outcomes for comparison with actual outcomes (Williams *et al.* 2009).

- Incrementally reduces uncertainty and management risks by improving understanding. The challenge then becomes how to use the flexibility provided by an adaptive management approach in a way that balances gaining knowledge to improve management in the future and achieving the best near-term outcome (Stankey and Allan 2009).

B. Adaptive Management Resource Needs

The key issue is whether existing efforts, individually and collectively, have enough capacity – both in terms of staff capacity and senior researcher capacity, and have stable funding to ensure a long-term scientific basis to support successful adaptive management decision making that is relevant to project operations now and in the future.

C. Time Scale of Adaptive Management Program/Implementation and Relationship of Adaptive Management to Real-Time Operations

- Adaptive management of the SWP/CVP will consider the multiple different time-scales applicable to CVP/SWP actions. Adaptive management changes to SWP/CVP operations are expected to be implemented on an annual or longer (multi-year) basis.
- Under the current BiOps and future operations under CWF, a “real-time operations” (RTO) mechanism will allow for adjustment of water operations, within established conditions, to respond in real time to changing conditions for the purpose of maximizing opportunities to benefit covered fish species. The adaptive management and decision-making processes described here do not apply to these real-time operations because individual decisions have to be made too quickly. However, changing operational criteria in existing BiOps and CWF authorizations through the adaptive management process may affect how real-time operations are implemented.

D. Adaptive Management Conceptual Model

The diagram below (Figure 1) conceptualizes that different decisions are made at different time-scales of adaptive management for CWF and 2008/2009 BiOps on the combined CVP/SWP operations (multi-year or annual; and real-time, daily or weekly). The arrows indicate the linkage between information flowing from real time operations to annual operations, and that this information may be used in the adaptive management process to make changes on annual or multi-year time scales. The diagram also illustrates how different agencies and workgroups interact with these different time scales, and the dependencies between them.

Adaptive Management Conceptual Model

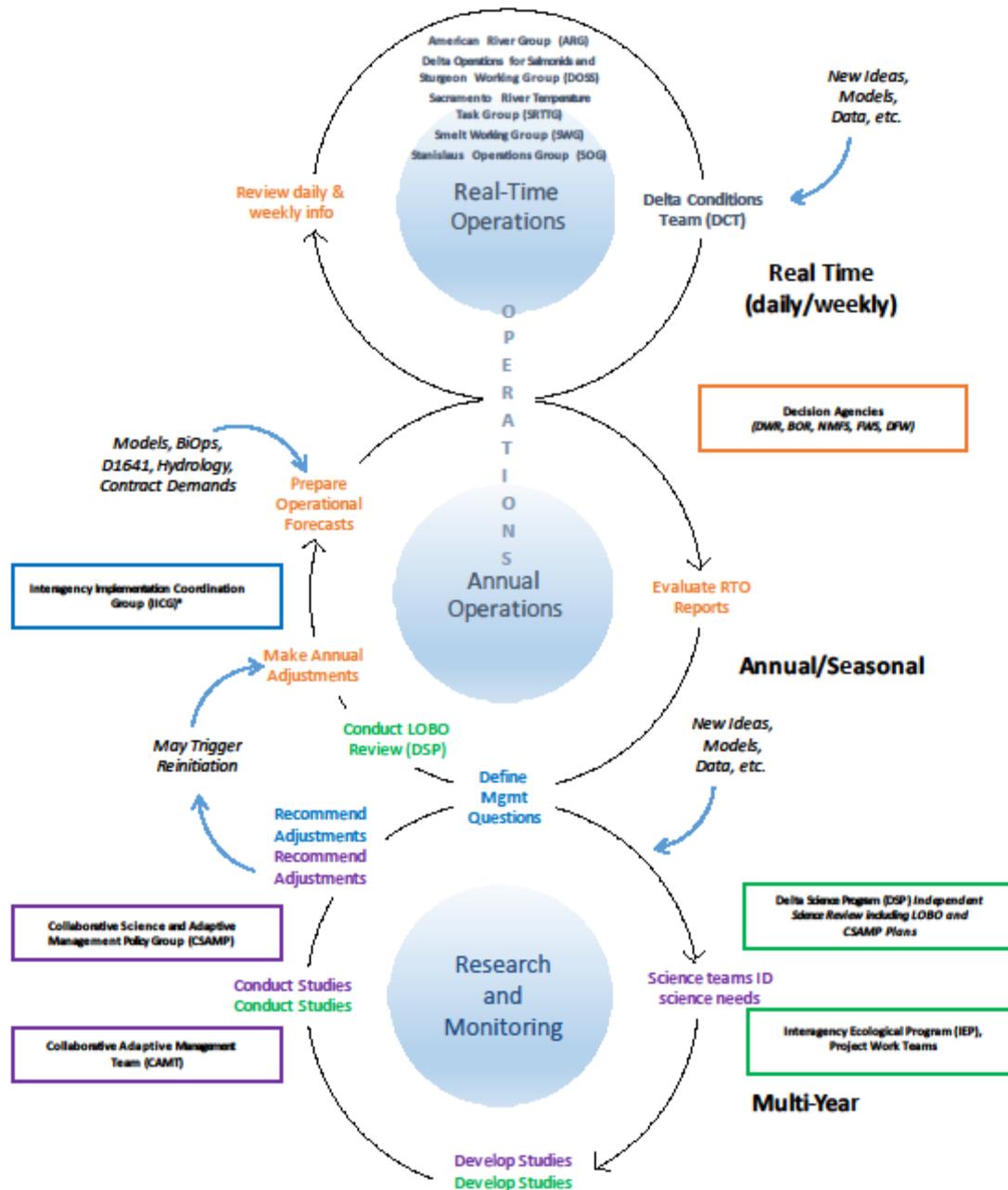


Figure 1. Depiction of multiple time-scales of adaptive management for CWF and 2008/2009 BiOps.

III. CURRENT EFFORTS

Important efforts are underway to implement science-based adaptive management to improve scientific basis of operational decisions on annual or multi-year time scales. The Adaptive Management Program will build on and augment the existing and planned efforts summarized below that are developing and implementing science to apply adaptive management principles to the Delta ecosystem. As the Adaptive Management Program is developed, specific linkage to each of these efforts will be defined.

A. Delta Stewardship Council, Delta Independent Science Board (DISB) and Delta Science Program (DSP)

- Established by 2009 Delta Reform Act, the Delta Stewardship Council is charged with achieving the co-equal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem.
- The DISB provides a standing board of nationally or internationally prominent scientists with appropriate expertise to evaluate the broad range of scientific programs that support adaptive management of the Delta. The DISB will provide oversight of the scientific research, monitoring, and assessment programs that support adaptive management of the Delta through periodic reviews of each of those programs and reports to the Delta Stewardship Council.
- The Delta Independent Science Board (DISB) in January 2016 provided insights regarding the way adaptive management has been applied to the Delta ecosystem as well as a number of recommendations for future implementation, in their report titled “Improving Adaptive Management in the Sacramento-San Joaquin Delta.” Key findings and recommendations included:
 - Agencies must become more actively engaged in collaborations;
 - Adaptive Management must be identified as a high Priority;
 - Support Adaptive Management with dependable and flexible funding;
 - Design and support monitoring to fit the magnitude of management actions and timing of ecosystem processes;
 - Develop a framework for setting decision points or thresholds that would trigger a management response;
 - Use restoration sites to test adaptive management and monitoring protocols.
- The Delta Science Program’s mission is to provide the best possible unbiased scientific information to inform water and environmental decision making in the Bay-Delta region.
- The Delta Science Program’s objectives are:
 - Initiate, evaluate and fund research that will fill critical gaps in the understanding of the current and changing Bay-Delta system.
 - Facilitate analysis and synthesis of scientific information across disciplines.
 - Promote and provide independent, scientific peer review of processes, plans, programs, and products.
 - Coordinate with agencies to promote science-based adaptive management.
 - Interpret and communicate scientific information to policy- and decision-makers, scientists, and the public.
 - Foster activities that build the community of Delta science.

- The Delta Science Program has particular expertise and experience organizing and facilitating independent scientific reviews. It also has primary responsibility for developing and implementing the Delta Science Plan. The Delta Science Program is expected to support CWF in the review of monitoring and research methods and results, and to provide technical support to the adaptive management process.

B. CSAMP/CAMT

- Established in 2013 during federal litigation of 2008/2009 BiOps. In 2015, after litigation ended, parties agreed to continue the Collaborative Science and Adaptive Management Program (CSAMP) process to promote the collaborative development of scientific information to inform sound decision-making in the future.
- CSAMP is intended to be a robust science and adaptive management collaboration of managers, scientists, and experts from the Five Agencies, Public Water Agencies ('PWAs') and the NGO community with the intent to inform the management actions consistent with the existing BiOps (and Reasonable and Prudent Alternatives (RPA's)) and consideration of alternative management actions.
- CSAMP Organization (four-tiers)
 - 1) Policy Group consisting of agency directors and top-level executives from the entities that participate in CSAMP;
 - 2) The Collaborative Adaptive Management Team (CAMT) made up of managers and staff scientists that serve at the direction of the Policy Group;
 - 3) Scoping Teams created on an as-needed basis to scope specific science studies; and
 - 4) Investigators contracted to conduct studies.
- CSAMP Mission Statement (7/23/2013)

The Collaborative Adaptive Management Team (CAMT) will work, with a sense of urgency, to develop a robust science and adaptive management program that will inform both the implementation of the current Biological Opinions, including interim operations; and the development of revised Biological Opinions.
- CSAMP Current Status
 - Develop a Five-Year Plan for CAMT.
 - Focus on completing studies initiated in 2014 and identifying new initiatives based on the results of these studies.
 - Scoping teams and principle investigators developing analysis and synthesis concerning Delta Smelt Entrainment, Gear Efficiency, Fall Habitat, and Salmonid survival. Reports will identify key findings, issues and recommendations for next steps.
 - CAMT will evaluate and prioritize recommended next steps and submit high priority efforts to CSAMP Policy Team to incorporate into 5-year plan.
 - Items in CAMT 5-year plan may also support and contribute to advancing the objectives of other efforts to include CWF and Interagency Ecological Program (IEP). The Five Agency group will need to ensure that efforts being

implemented via CAMT or IEP are integrated and continue to move forward in those forums.

C. Interagency Ecological Program

For over 40 years, IEP State and federal natural resource and regulatory agencies have worked together to monitor and study ecological changes and processes in the Bay-Delta, working together to develop a better understanding of the estuary's ecology and the effects of, among other things, the SWP/CVP operations on the physical, chemical, and biological conditions of the estuary.

- IEP Organization. Nine agencies make-up IEP: State - DWR, CDFW, and the State Water Resources Control Board; Federal - USFWS, Reclamation, USGS, USACE, NMFS, and EPA; and, two partnering organizations, the San Francisco Estuary Institute and the Delta Science Program.
- IEP Mission: Provide and integrate relevant and timely ecological information for management of the Bay-Delta ecosystem and the water that flows through it, accomplished by collaborative and scientifically sound monitoring, research, modeling, and synthesis efforts for various aspects of the aquatic ecosystem. IEP addresses high priority management and policy science needs to meet the purposes and fulfill responsibilities under State and Federal regulatory requirements, relying on multidisciplinary teams of agency, academic, non-governmental agencies (NGO), and other scientists to accomplish its mission.
- IEP program: synthesis of current information to inform decision making and identify knowledge gaps and identify science needs, through the Management Assessment and Synthesis Team (MAST) for pelagic species and the Delta ecosystem and for salmonids and sturgeon by the Salmon and Sturgeon Assessment of Indicators by Life stage (SAIL) Team.
- IEP Monitoring: Activities document CVP and SWP compliance with water rights decisions and ESA/CESA authorization conditions and supporting real time operations decision making. Most monitoring focuses on open-water areas and major Delta waterways conveying water to the SWP/CVP facilities in the south Delta and downstream, including the entire Bay-Delta area. IEP will be a primary component in implementing the Adaptive Management Program's monitoring and research.
- IEP Reporting: Publicly accessible data that include fish status and trends, water quality, estuarine hydrodynamics, and food web monitoring.
- IEP *Science Agenda*:
 - Focus on overarching management challenges in the next 3-5 years (http://www.water.ca.gov/iep/docs/2016_IEP_Science_Agenda_FINAL.pdf).
 - Outline important objectives by identifying and organizing science needs in the context of conceptual models, related information gaps and uncertainties, and strategies and priorities.
 - Guide IEP agencies as they select studies for the annual IEP Work Plan. (http://www.water.ca.gov/iep/docs/2016IEPWorkPlan_04-04-2016.pdf) and

- employ strategies to achieve the goals of the Strategic Plan (http://www.water.ca.gov/iep/docs/IEP_Strategic_Plan102214.pdf).
- Adapt and respond with scientific products that serve evolving priority management needs and support adaptive management under the BiOps and CWF.
- Broad Themes, or topics to describe where science is most needed to inform management in the near-term:
 - Effects of Climate Change and Extreme Events
 - Understanding Estuary Food Webs
 - Ecological Contributions of Restored Areas
 - Restoring Native Species and Communities
 - Impacts of Non-Native Species

D. State & Federal Contractors Water Agency (SFWCA) Science Program
[To be added: background, and program info.]

IV. PLANNED EFFORTS

Additional efforts/groups may be needed to fulfill all aspects of the Adaptive Management Program especially those resulting from implementation of CWF. One such group is currently being developed and is described below.

Interagency Implementation and Coordination Group (IICG)

- Coordination body, co-led by Reclamation and DWR.
- Roles and responsibilities in implementing this framework are being developed and will be set-forth in an MOA.
- Members include a designee from each of USFWS, NMFS, CDFW, DWR, Reclamation, SLDMWA, and the State Water Contractors (SWC); and additional agency staff and/or consultants may participate in providing technical or other support.
- “Air-traffic control” body that will provide input and assistance to the adaptive management process. For example, they would:
 1. Support science activities developed through the CSAMP process.
 2. Promote and fund scientific activities/monitoring.
 3. Refer, develop, or solicit proposals through existing or new individuals or entities, the IEP, etc.
 4. Refer management related actions or proposals as appropriate to Delta Science Program for review by an independent science panel (“LOBO IRP” example).
 5. Assure transparency consistent with the requirements of the Delta Plan.
 6. Review funding commitments and any implementation issues relative to priorities and recommendations from the DSP, CAMT, or related adaptive management fora.
 7. Identify and secure needed infrastructure and resources to support scientific activities/monitoring.
 8. Review scientific information and recommend changes to monitoring schema and management actions to the appropriate agency.

9. Establish mechanisms *e.g.* annual report, for developing and implementing adaptive management changes.

V. CONCEPTUAL FRAMEWORK FOR ADAPTIVE MANAGEMENT

The Adaptive Management Program will be modeled on the Comprehensive Everglades Restoration Plan (CERP) due to its success in fostering stakeholder involvement and collaborative science. (see CERP,

http://141.232.10.32/pm/recover/recover_docs/am/rec_am_strategy_brochure.pdf)

The Program will include specific adaptive management elements described in the Delta Science Plan and recommendations from the Delta Independent Science Board (ISB), the Independent Review Panel Report for the 2016 California WaterFix Science Peer Review, and other reviews and relevant guidance.

The Adaptive Management Program will be comprised of four components, referred to as “phases,” of adaptive management: (1) Plan; (2) Assess; (3) Integrate; and (4) Adapt. See Figure 2 below and Figures 3-6 that diagram details of each phase.

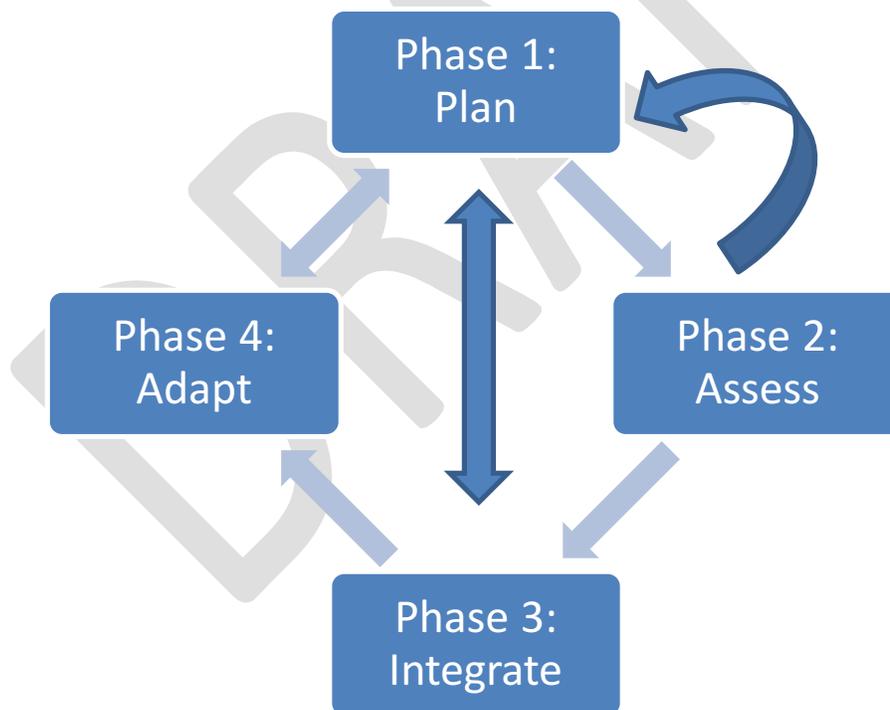


Figure 2. Four phase framework of adaptive management for CWF and 2008/2009 BiOps on the combined CVP/SWP operations

A. Phase 1 – Plan

Defining and bounding the management problem, including the setting of management and research objectives

Design and Operations Planning in the Context of Endangered Species Act and CESA

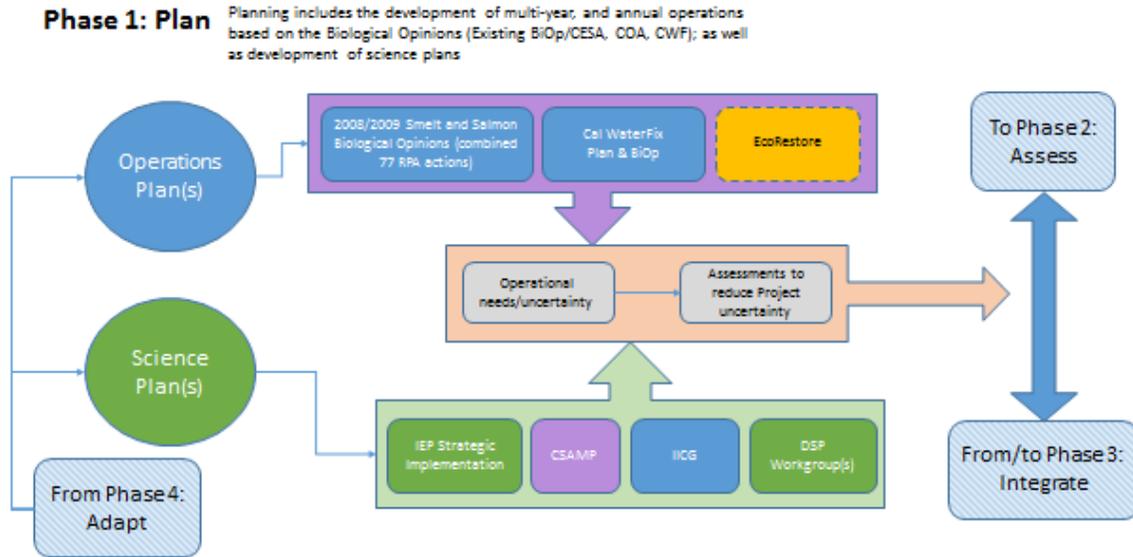


Figure 3. Phase 1, Plan, of adaptive management program for CWF and 2008/2009 BiOps on the combined CVP/SWP operations.

1. Multi-year Planning:

Implementation of the CVP/SWP under the current BiOps and associated CESA authorizations involves ongoing review and adjustment under provisions for adaptive management, which is accomplished primarily through the annual Long-term Operations Biological Opinion (LOBO) review. There are a number of uncertainties related to the effectiveness of the RPAs and their effects on water supply and operations that are the subject of ongoing scientific investigation and efforts to improve monitoring to improve the detection of covered species. CWF would modify the existing State Water Project to construct and operate three new screened diversions in the north Delta. These new facilities would be operated in conjunction with the existing south Delta diversion facilities to reduce reliance on the south Delta facilities, improve operational flexibility and water supply reliability. The project if approved would be constructed over a 10 year time period and begin operations sometime after 2025.

2. Setting Objectives and Triggers:

In most adaptive management programs, establishing measurable objectives is an important component of the design and plan step. Species specific objectives will be identified for the

Adaptive Management Program as an initial set of objectives, subject to further refinement, against which performance of operations and other management actions can be assessed.

Given that adaptive management is intended to accommodate change both in the management of a resource and the corresponding response; objective triggers are an essential component of the adaptive management framework for knowing when to make changes to the project. Triggers are defined pre-set measurable conditions that trigger an adaptive action. For the purposes of this Framework triggers will be focused on longer term outcomes. The Five Agencies examined the triggers contained in the Federal Columbia River Power System adaptive management program, and may develop something similar for this Framework approach.

In implementing the BiOps and CWF, the Five Agencies will rely on CSAMP and IEP for developing science priorities to evaluate water operations, RPA actions, and related stressors.

3. Annual Planning and Operations:

Based on experience gained through annual operations management and ongoing monitoring and emerging scientific understanding, changes to operating criteria, methods for monitoring and assessing risk to species from water operations can be developed and implemented subject to review and consistency with the requirements of the BiOps and CESA authorizations.

4. Monitoring and Research Planning:

Bounding ecological uncertainty with regards to management outcomes is critical to any adaptive management program and there are two key aspects involved in addressing that uncertainty: 1) anticipate and clearly define uncertainties in the near and long-term; and 2) address those uncertainties through a science program designed to evaluate the effects for existing operational requirements and management actions and in anticipation of future modified facilities and operations (CWF) and climate change.

The Five Agencies will work through the IEP, Collaborative Science and Adaptive Management Process (CSAMP), EcoRestore, DSP, and NOAA Southwest Fishery Science Center to prioritize monitoring and research specific to meeting needs and reducing uncertainty related to water operations and CWF.

5. Annual Review:

In order to ensure the objectives of the BiOps and CESA authorizations are being realized and to support water supply reliability, periodic updates of annual operations will be conducted. These updates will be scheduled to occur in conjunction with the LOBO review and will include an evaluation of operations using new and/or updated modeling, integrating the latest scientific, technical, and planning information (*i.e.* Phase 3: Integrate). When appropriate, results of these operational evaluations will be used to change management actions within Phase 3 that are necessary to address operational needs and uncertainty (see Phase 1).

B. Phase 2 - Assess: Operations, Monitoring and Research

Represent existing understanding through operations while identifying uncertainty and alternate hypotheses related to monitoring and research

As recommended in the DISB’s report *Flows and Fish in the Sacramento-San Joaquin Delta: Strategic Research Needs in Support of Adaptive Management* (August 2015), there is a need to implement integrative scientific approaches grounded on management questions and focused on processes, drivers and predictions. The approach outlined in Figure 4 best addresses the complexities of the ecological responses being examined by individual research projects and tracked by system-wide level monitoring.

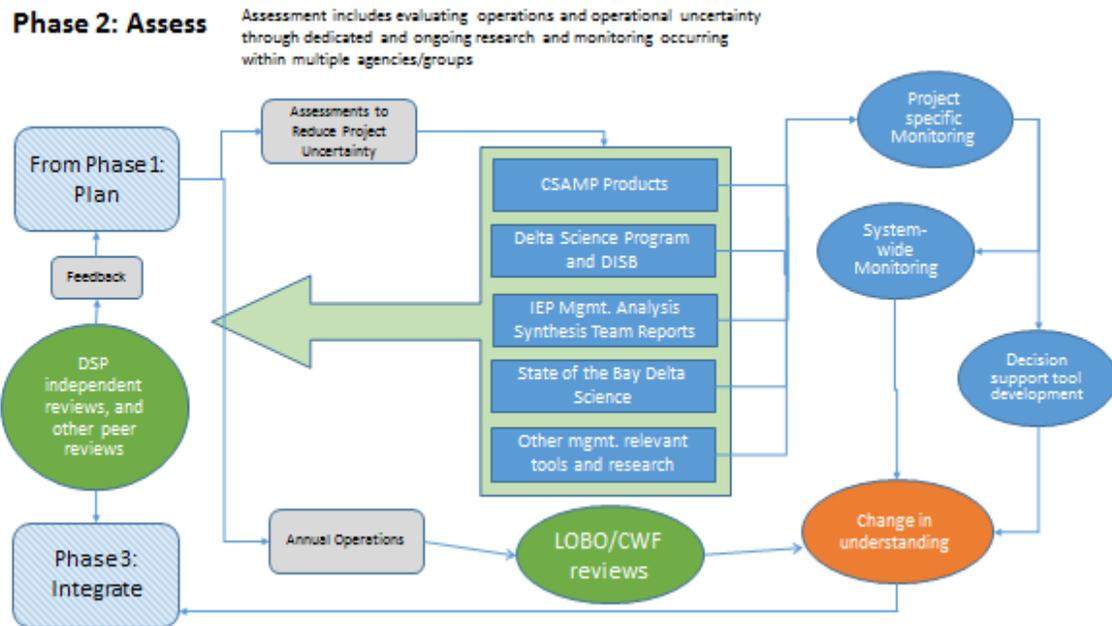


Figure 4. Phase 2, Assess, of adaptive management program for CWF and 2008/2009 BiOps on the combined CVP/SWP operations.

Phase 2 requires development and execution of a scientifically rigorous monitoring and assessment program to analyze and understand responses of the ecosystem to a particular management regime. This Framework’s assessment relies on the implementation of an integrated monitoring network for water operations that incorporates many project specific monitoring research actions.

Additionally, the DISP and DSP will at times be asked to provide a technical review and feedback regarding the ongoing and future research priorities and water operations or habitat restoration actions. These independent reviews, along with the research products from the many

Delta science-related groups, will provide greater understanding and can be used to inform new management and research options as detailed in Phase 3 (Integrate).

C. Phase 3 - Integrate: Operations, Monitoring and Research

Reflect on outcomes and consider new approaches to management and research based on new understanding.

This Phase involves developing recommendations for adaptive changes to management actions and monitoring and research consistent with ESA and CESA authorizations through a process of engaging stakeholders, scientists and other relevant groups to collaborate in the development of management and research. The process is intended to address the needs presented by new understanding derived from monitoring, research and synthesis and operations assessment (Phase 2). The options must be science-based and operation-relevant and address the needs and uncertainties that have been identified. Activities encompassed within Phase 3 are triggered by new knowledge that reveals a potential opportunity to improve conditions or operations in the Delta and/or its tributaries that would then motivate a change to project implementation. The product of Phase 3 is an assessment report.

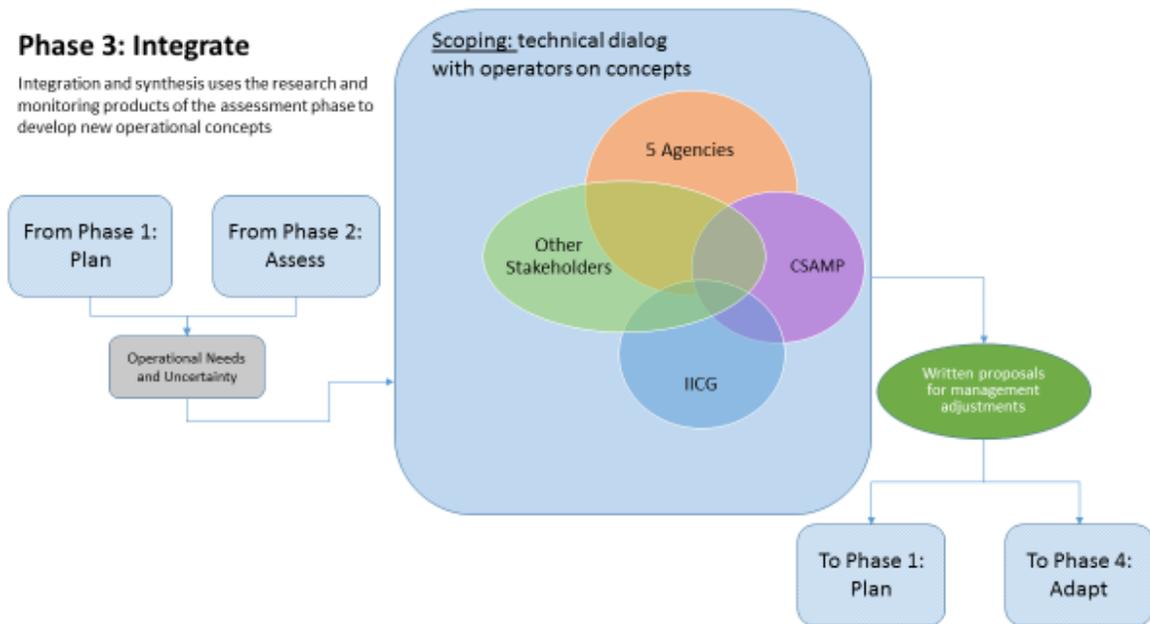


Figure 5. Phase 3, Integrate, of adaptive management program for CWF and 2008/2009 BiOps on the combined CVP/SWP operations.

Within Phase 3, the objective of Scoping is to determine whether assessment feedback is significant enough to trigger consideration of changes to a management action and the monitoring and research program, if so, then to diagnose the resources and actions needed to

implement the change. Scoping is accomplished via a structured dialogue involving managers, scientists and stakeholders. The goal of the dialogue is to develop a common interpretation and understanding of the monitoring and research products. If it is determined that the new understanding is a significant insight or change in understanding that is relevant to making a change in implementation of management actions, the agencies will then develop management measures, and more effective management approaches.

The final activity associated with Phase 3 is the formulation of a management recommendation during which alternative approaches are evaluated in Phase 1 and 2 as appropriate and a management action recommendation is made. The final product is a report submitted to the Five Agency Directors for approval (Phase 4).

D. Phase 4 -Adapt and Adopt

Revise models and or management actions based on what’s been learned.

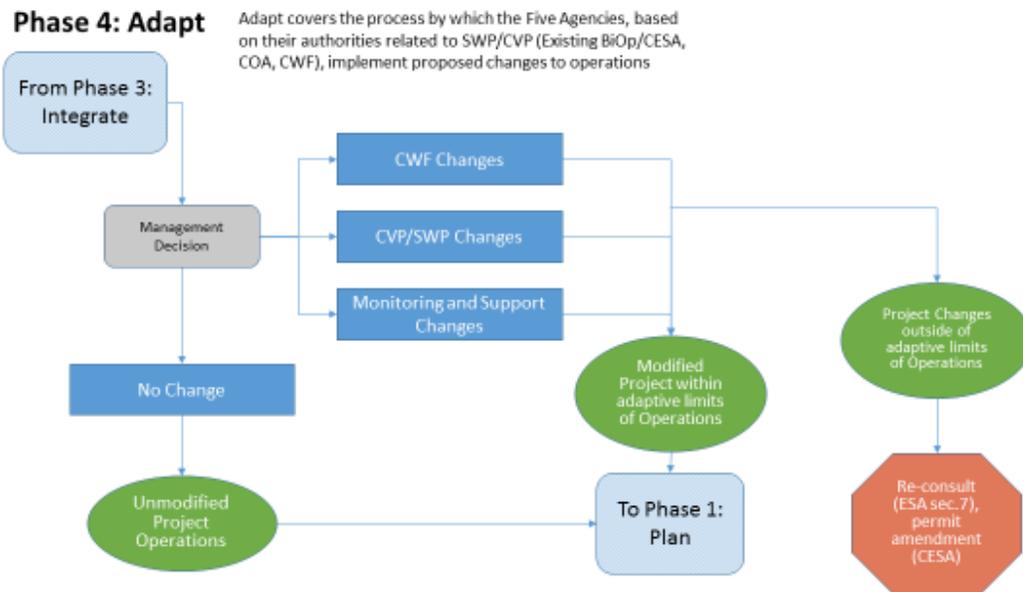


Figure 6. Phase 4, Adapt, of adaptive management program for CWF and 2008/2009 BiOps on the combined CVP/SWP operations.

The fourth phase of the adaptive management framework revolves around the decision to implement a management change through adjustments in water operations, restoration tactics, or monitoring and research support (Figure 6) related to the project. Recommendations from Phase 3 are used to make management decisions.

Five Agencies, based on their authorities related to CVP/SWP (Existing BiOps/CESA, COA, CWF) as implementing or regulatory agencies, would consider management changes, such as:

- Changes in project operations within BiOps and CESA authorizations, consistent with WQCP.
- Changes in monitoring to support project operations.
- Re-initiation of consultation (ESA Section 7) and 2081(b) permit amendment (CESA) to address changes outside of existing authorizations.

VI. TOOLS AND SCIENTIFIC SUPPORT FOR LISTED SPECIES

The current understanding of science needs to support adaptive management is based on a variety of sources. In developing this information, this Framework will rely on peer-reviewed published literature as much as possible. When such literature is not available, it will utilize agency reports that are available to the public, and in some cases information from reports or articles that have been submitted to scientific journals but that have not yet been accepted for publication. Conceptual models and hypotheses of how ecosystems work and species respond by life stage to ecological processes or stressors are developed based on this information. Conceptual models will be used to identify areas of uncertainty and guide the formulation of the science program that supports the adaptive management framework. The below sections will outline a commitment from the Five Agencies to invest in more robust tools, monitoring and research efforts to support this adaptive management framework.

A. Delta Smelt

Research, monitoring and tools for understanding (to be developed)

B. Longfin Smelt

Research, monitoring and tools for understanding (to be developed)

C. Anadromous fish

Research, monitoring and tools for understanding (to be developed)

D. Screen Design (to be developed)

E. Habitat Restoration (to be developed)

VII. Funding [to be added]

VIII. Summary [to be added]

IX. References [to be added]